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MEMORANDUM

TO: Mr. Jeff White, Mr. Eric Bates / Newmont Mining Corporation

CC: Dr. Richard Dawson / Norwest Corporation;
Mr. Paul Pryor, Mr. David Nicholas / Call & Nicholas, Inc.

FROM: Ross Barkley, P.E., Senior Engineer

DATE: 13 April 2005

SUBJECT: Recommended Materials Testing Program for the Analysis of the North Dump

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1.0 INTRODUCTION

Ross Barkley visited the Norwest Corporation offices in Vancouver on March 11, 2005 to discuss the materials testing program with Dr. Richard Dawson, Vice President, and other Norwest personnel, including Mr. Gordon McKenna, Mr. Jay Horton, and Mr. Calvin Bose. Dr. Dawson will be providing review and technical assistance to Newmont and Call & Nicholas, Inc. during the forensics analysis and the mitigation of the North Dump failure at the Eastern Nevada Operations of the Newmont Corporation.

Topics that were discussed during this visit included:

1. The failure geometry and potential mechanisms of failure
2. Clay characteristics and the relationship of clay characterization methods such as Atterberg limits to the shear strength of the material
3. Testing methods to determine the fully softened and the residual shear strength of the clays forming the three lower lifts of the North Dump
4. Low volume piezometer installations in fully grouted holes
5. Installation of inclinometer casing and the frequency of readings in a displacing slope

2.0 FAILURE GEOMETRY AND POTENTIAL MECHANISMS OF FAILURE

The pre-failure geometry of the North Dump consisted of an 18-degree slope angle in the lower three lifts, which were composed of Carlin Formation lacustrine sediments and oxide rock from the initial phases of stripping of the Gold Quarry Pit. The slope height of the lower three lifts was roughly 225 feet. The low-grade stock that was subsequently placed on the Carlin and oxide waste constitutes, roughly, the upper 200 feet of the slope. The low-grade stock was placed at a slope angle of 28 to 30 degrees. Figure 1 shows the pre- and post-failure dump geometry along Section 1, the location of which is shown on Figure 2, a plan map of the dump. The overall post-failure slope angle is 10 to 12 degrees.

Based on field observations and the laser-scan survey of the post-failure surface, it appears that the base of the failure extended into Lift 1, the lowest lift, of the dump. The back scarp and bowl shaped geometry suggest a near circular failure with a possible tension crack extending part of the way through of the low-grade stock. Eyewitness accounts of the failure indicate that the failure mass exited the slope face above the actual toe of the North Dump. Initial back-analyses suggest that the failure mass prefers to exit at or near the contact between Lift 1 and Lift 2.

Based on Dr. Dawson’s experience, as well as back-analyses and materials testing performed by Mesri, et al (2003)[1], it is likely that much of the material in the passive block of the failure probably strained to the point of mobilizing residual shear strengths. Dawson's experience and the Mesri studies indicate that strengths mobilized in the active block of these types of failures in stiff clays and clay shales approach strengths of the fully softened state of strain.

3.0 SITE INVESTIGATION

The site investigation includes the drilling of a number of holes into the failure mass and into the surrounding areas of the dump. The holes drilled into the failure mass and into the dump slope northwest of the failure will have inclinometer casing and piezometers installed.

1 Mesri, G. and Shahien, M., 2002,Residula Shear Strength Mobilized in First-Time Slope Failures: Journal of Geotechnical and Geoenvironmental Engineering, ASCE, v. 129, is. 1, p. 12-31. [Jan. 2003]

3.1 Inclinometers

Inclinometer casing will be installed in the holes as indicated on Figure 2. Two inclinometer installations will be constructed within the failure mass to locate the depth of the shear surface and three will be constructed northwest of the failure to monitor and locate the limits of dump slope movements observed in this area.

Because the slope is moving within the current slide mass and to the north of the slide mass, these installations will probably not be long-lived. Both the A and B axes of the inclinometer must be read and the readings should be allowed to stabilize at each measurement point. Care must be exercised in reading the inclinometer. Measurement points cannot be skipped. It is good practice to have the same person read the inclinometers during every survey. After the first day, the holes should be measured daily until the casing is too deformed to read the inclinometer. Because the casing is displacing, a dummy tool should be run in the casing each time to make sure that the inclinometer will pass without getting stuck in the hole.

The inclinometer casings should be installed to a minimum depth of 30 feet below the contact of the original ground surface and the bottom of Lift 1. It is reasonably certain that the failure does not extend below this contact, so the readings in the lowest 30 feet should be used to correct for instrument shift. Any drift noticed in this part of the hole can be subtracted out of the readings in the displacing zone to achieve an accurate determination of the slope deformation.

3.2 Piezometers

Low-volume vibrating wire piezometers are being installed in the holes used to sound the lifts of the Gold Quarry North Dump. The piezometers will determine water pressures and gradients within the dump. Determining the water pressures within the dump is a very important aspect of determining both the cause of the failure and what the shear strengths were at the time of failure. To determine if there is any seepage below the contact between the original ground surface and the dump, one piezometer should be installed 10 feet below the contact between the original ground and Lift 1. Another piezometer should be installed five feet above that same contact. A third piezometer is recommended at the center of Lift 1 material. The proposed and completed locations for the piezometers are shown on Figure 2.

The piezometers can be grouted into the holes provided that the permeability of the grout is equal to or less than the soil horizon being measured. A grout recipe of 94 pounds of Type 1 or Type 2 Portland cement, 25 pounds of bentonite, and 30 gallons of water is recommended. The tip of the piezometer should be enclosed in a filter pack of clean quartz sand to protect the porous tip from infiltration of clay or cement particles. If the tip is not protected, the cement particles will set and prevent the diaphragm in the piezometer from functioning properly.

The piezometer and porous tip should be saturated with clean de-aired water. Remove the porous tip to allow this water to saturate the piezometer diaphragm more quickly, then replace the tip when the interior of the piezometer is full of water.

Installing the piezometers with the tip toward the top of the hole aids in the escape of air that may be entrained in the piezometer. However, if taping the piezometer and filter pack to the cable to achieve this configuration could cause the piezometers to become stuck or hinder passage to their desired placement positions, then install them tip down.

If possible, the piezometer calibration should be checked by measuring the water pressure in several depths of water. The piezometer should be able to accurately measure these water heads. If a piezometer does not give an accurate measurement, it should be shelved and a different piezometer should be used.

3.3 Sampling

A library of samples from the sonic drilling will be collected at a frequency of one every ten feet. The specimens for laboratory testing will be collected from this library.

4.0 LABORATORY TESTING

The strength of clay depends on the geologic history of deposition, consolidation and erosion. Over time, an overconsolidated clay deforms due to the unloading caused by erosion. Joint formation, and primary and secondary swelling, lead to the deterioration of interparticle bonds. In the end, the fully softened stiff clay has strained to a point of having a strength equal to that of a normally consolidated clay.

Mesri, et al (2003) reported that the intact, fully softened, and residual shear strengths of clays depend on the volume of clay-size particles in a soil and on the plasticity index. These strengths also depend on the normal stress applied to the test samples. Empirical equations presented by these researchers relate secant friction angles measured at various normal stresses to the plasticity index of the clay for the fully softened and the residual strain conditions. These correlations work well for platy shaped clays, but may be suspect for clays that are not platy. The magnitude of drop in shear strength between the fully softened and the residual strain states was reported to be a function of the plasticity index. The maximum difference in strength was observed at plasticity indices close to 50 percent. Above that value, clay particle orientation tends to be more face-to-face, thus there is not as great a difference in the clay structure and interparticle bonds. At values lower than 50 percent, the clay particles are less susceptible to re-orientation due to stress and strain changes.

4.1 Soil Characterization Testing

Based on this work, it will be important to perform sieve analyses, including hydrometer tests and Atterberg limit tests for several samples in each of the first three lifts. Because it is likely that the material constituting Lift 1 was a key to the dump instability, 15 sieves, hydrometers, and Atterberg Limit tests will be performed on this material. The same tests will be performed for the materials constituting Lifts 2 and 3; though 12 samples in each of these lifts will suffice.

In addition to performing the sieves, hydrometers, and Atterberg Limits, the *in situ* water content of the samples will be measured, along with the specific gravity of the solids. Ph and conductivities will also be determined on pastes of the clay to determine the acidity. A subset of the samples will be sent to a specialty lab to determine the types of clays present in the lower dump lifts.

Samples for testing will be collected from trenches and from the sonic drilling program, which is currently being performed. Samples from the drilling consist of six-inch-diameter cores. Figure 2 shows the proposed and completed locations for sonic drilling and trenching.

The attached table, Table 1, lists the characterization tests that will be performed in the laboratory. Note that characterization tests will be performed on samples of PAG (4 samples) and the silty foundation soils (6 samples).

4.2 Fully Softened and Residual Shear Strength Tests

The residual shear strength of materials from each lift will be determined by laboratory shear tests. Additionally, the peaks of the first consolidation load of the intact dump samples will be used to determine the undisturbed strengths. The samples will be tested according to ASTM standards at the lowest possible shear strain rate. The samples will be flooded with distilled water and consolidated under each normal load before shearing. Shearing will be performed in the forward and reverse direction until residual strengths are achieved. Up to 10 direct shear tests will be performed on samples collected from each lift. Four traces will be performed for each direct shear sample at normal stresses of 7, 15, 60, and 175 psi.

According to Mesri (2003), the fully softened strengths are analogous to the peak strengths of remolded samples. On select shear tests, a sample will be remolded prior to the application of each normal load. After consolidating under each normal load, the peak strengths will be determined to compare with the peak strengths from the first normal loads applied to the intact dump samples.

In addition to standard direct shear tests, ring shear tests will be performed on five samples of Lift 1 clay. The ring shear testing will be performed at the University of Illinois under Dr. Mesri's supervision. Ring shear tests provide an accurate determination of the residual shear strength of clay. The fully softened strengths will also be determined.

Table 1 displays the recommended shear test program for the analysis of the strengths of the materials deposited in Lifts 1, 2, and 3, as well as four samples of PAG and six samples of foundation sandy silts.

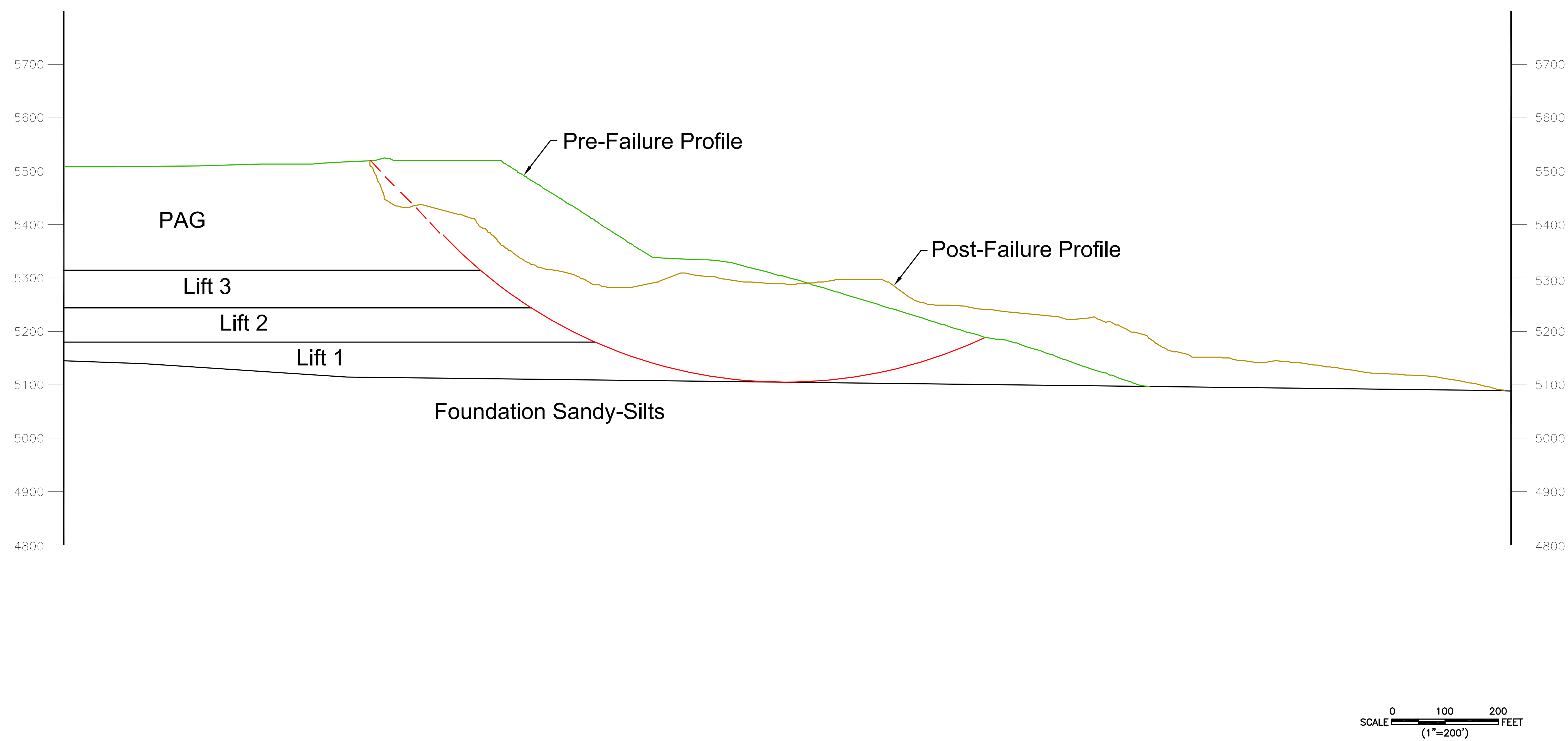
Table 1. Materials Testing Program – Number of Tests

	Paste Conductivity[1A]	Paste pH[1B]	Moisture Content[2]	Wet Sieve[3]	Specific Gravity of Solids[4A]	Hydrometer[4B]	Atterberg Limits[5]	X-Ray Diffraction	CNI Direct Shear[6]	U. of I. Ring Shears
PAG	4	4	4	4	4		4		4	
Lift 3	12	12	12	12	12	12	12		10	
Lift 2	12	12	12	12	12	12	12	4	10	
Lift 1	15	15	15	15	15	15	15	4	10	5
Fndtn	6	6	6	6	6	6	6		6	

* All characterization tests will be performed for all Direct Shear samples.

NOTES:

1A – ASTM G57 Field Measurement (Resistivity/Conductivity)
1B – ASTM G51 on CALTRANS 643 (pH)
2 – ASTM 2216
3 – ASTM D422 (Sieve with #200 wash)
4A – + #4 Fraction - ASTM C127 / - #4 Fraction - ASTM D854
4B – ASTM D422 (Sieve with Hydrometer)
5 – ASTM 4318 Method A, Wet Prep
6 – ASTM D3080



LEGEND

CALL & NICHOLAS, INC.
TUCSON, ARIZONA USA

DRAWN	DATE	CHECKED	APPROVED
LMC	4/05		

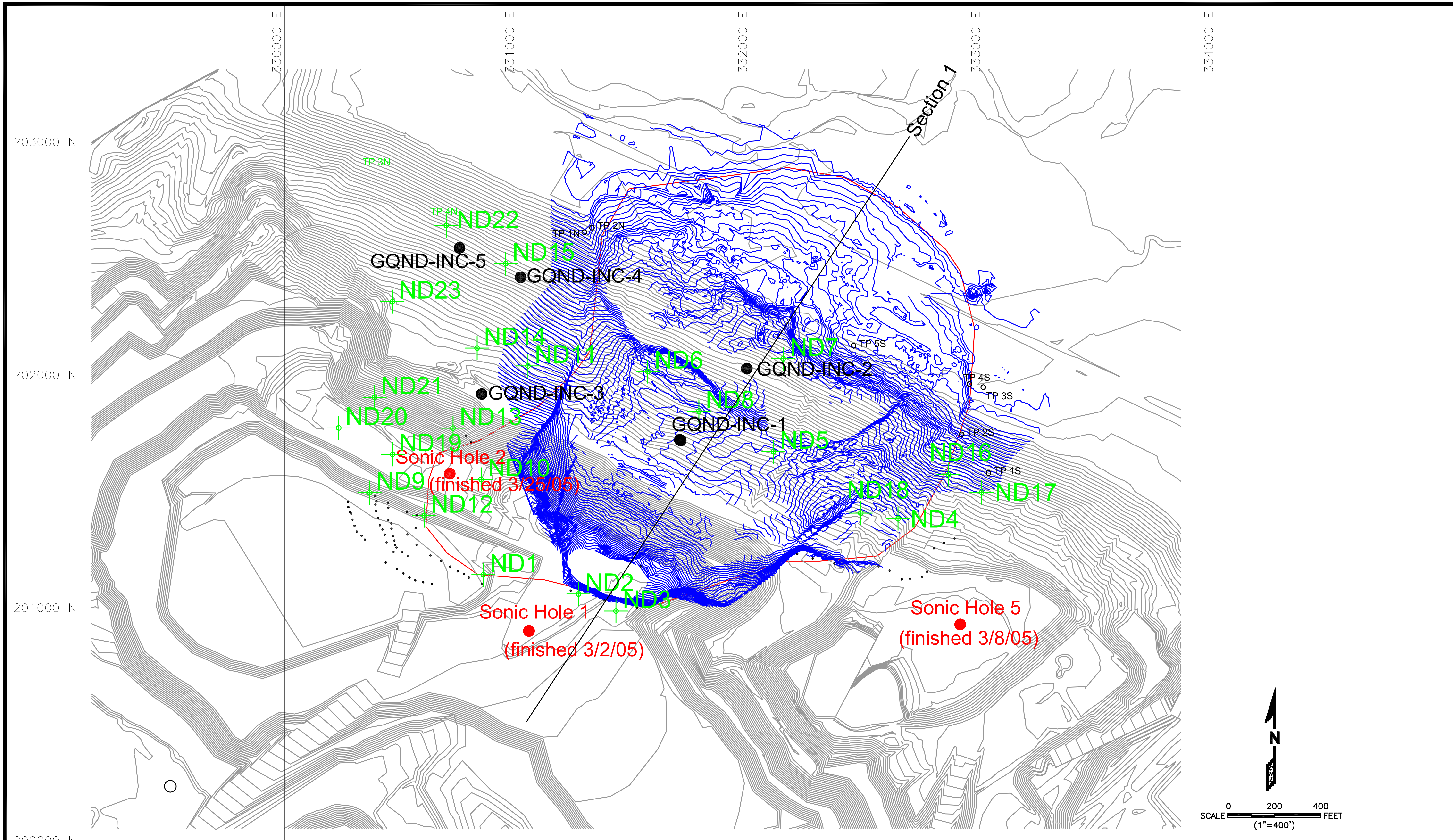
FILE NEWMONT\GQ_DUMP_FAILURE\POST_FAILURE_SECTIONS\NORDMP12_POST_FAIL.DWG

GOLD QUARRY NORTH DUMP
SECTION 1 PRE- AND
POST-FAILURE PROFILES

NEWMONT MINING CORP./GOLD QUARRY DUMP

SCALE 1"=200'

FIGURE 1



LEGEND

TP 4S = Completed Test Pit

TP 4N = Proposed Test Pit

= Tension Crack Location

All sonic holes will be instrumented with vibrating wire piezometers.

Hole 3 = Sonic Hole with Inclinometer Casing

Hole 5 = Sonic Hole

ND18 = Prism Location

CALL & NICHOLAS, INC.

TUCSON, ARIZONA USA

DRAWN LMC	DATE 3/05	CHECKED	APPROVED
FILE NEWMONT\GOLDQUARRY\2005_ACAD\NDUMPSLIDE_SONIC.DWG			

LOCATION OF SONIC HOLES AND TRENCHES FOR THE SITE INVESTIGATION OF THE GOLD QUARRY NORTH DUMP SLIDE

NEWMONT GOLD CORP./ GOLD QUARRY NORTH DUMP

SCALE 1"=400'	FIGURE 2